Webinar on Diaphragm Wall and Secant Bored Pile Wall Construction Challenges for Underground MRT Stations and Shafts

by Ir. Allan Chwee

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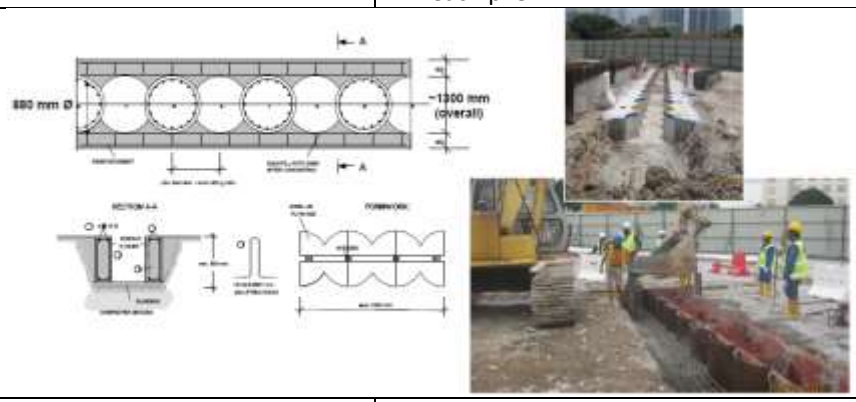
On 4 February 2021, the Geotechnical Engineering Technical Division (GETD) organised a webinar entitled "Diaphragm Wall and Secant Bored Pile Wall Construction Challenges for Underground Stations and Shafts in 1st Klang Valley MRT" which was presented by Mr. V. Vijayakumar who is the Executive Director of Bauer Malaysia. The webinar successfully attracted a large audience of 174 participants.

The Klang Valley SBK MRT Line (often referred to as the "MRT Kajang Line") had become fully operational since July 2017. It was the first MRT line in Malaysia and it connects Sungai Buloh to Kajang covering a total length of 51 km. Out of 51 km, 9.5 km is an underground section with 7 underground stations and several shafts. In this webinar, Mr Vijayakumar highlighted the geotechnical challenges encountered during diaphragm wall and secant bored pile wall construction at 5 underground stations, 3 shafts and the South Portal' 'cut-and-cover' section. The 5 underground stations are Warisan Merdeka, Pasar Seni, Cochrane, Pasar Rakyat and Taman Maluri, while the 3 shafts covered in the presentation are the Inai Shaft, Escape Shaft and Intervention Shaft No.2. Mr Vijayakumar pointed out that each station or shaft had its own unique set of geotechnical challenges. He began by describing the geotechnical challenges at Warisan Merdeka Station and ended with the technical issues encountered at Intervention Shaft No.2. The table below provides a summary of the technical details and geotechnical challenges at each of the station or shafts, as covered in the presentation.

Station / Shaft	***Details***	***Geotechnical Challenges***
Warisan Merdeka Station	• Commenced in July 2012, and completed in January 2013. • Diaphragm wall of 1200mm width. • Size of Station box: 148m x 24m. • Bentonite used as a stabilization fluid; a bentonite plant of 1200 m^3 capacity was set up on site with a BE 500 Desander. • Main equipment comprises a BC 40 cutter on an MC 96, and DHG grab on an MC 64.	• The main challenge was working with the cutter in Kenny Hill formation. The cutter had to be constantly checked and controlled to ensure correct verticality during excavation. • As the diaphragm wall was heavily reinforced, installation of the reinforcement cage had to be done carefully and with the assistance of 2 mobile cranes.
		
Pasar Seni Station	• Commenced in December 2012, and completed in November 2013. • Involved construction of 800mm and 1000mm wide diaphragm walls.	• This station is situated below existing buildings with basements. Hence, the position of the diaphragm wall had to be adjusted to enable its construction despite the presence of existing columns and a foundation slab.

		• The clearing and removal work in preparation for diaphragm wall construction required precise planning and coordination. Extensive temporary work was required to facilitate removal and extraction of existing structures.
		
Cochrane Station	• Commenced in August 2011, and completed in March 2012. • Involved 880mm and 1000mm diameter Secant Bored Pile (SBP) Walls. • Required 445 of 880mm SBP, and 133 of 1000mm SBP.	• The SBP wall comprised preliminary and secondary piles; reinforcement was provided in the secondary piles. • A guide wall was positioned to ensure the verticality and straightness of the SBP wall. • A significant challenge was the limestone formation which required pile termination to be closely controlled and confirmed by the Engineer's Representative. This was to ensure that adequate rock socketing was achieved for each pile.
		
Tun Razak Exchange Station (Pasar Rakyat)	• Commenced in July 2012, and completed in April 2013. • 880mm, 1180mm and 1500mm diameter SBP Walls were required. • Station box dimension: 168m x 27m. • Total piles installed: 582 nos.	• A unique challenge in this site was the application of 1500mm diameter secant bored piles in difficult karstic limestone formation.
		
Taman Maluri Station	• Commenced in November 2012, and completed in March 2014. • Involved construction of 880mm, 1000mm and 1500mm diameter SBP Walls. • Station box dimension: 305m x 27m. • Total piles installed: 854	• Traffic diversion was a major undertaking. Multiple sequencing of activities had to be implemented to permit construction in the middle of a busy road. • The presence of an overhead TNB cable restricted the available headroom for pile

		installation. The SBPs were eventually installed in short segments using a modified BG 9 rig due to the height limit of 7.1m. The maximum drill diameter was 880mm with a maximum drilling depth of 20m in soil.
		
South Portal	• Cut-and-Cover distance: 325m • Excavation depth: Up to 11m • Involved construction of 880mm, 1000mm and 1180mm diameter SBP Walls. • Total piles installed: 761	• Owing to the presence of high tension TNB cables which restricted the available headroom, a special low headroom rig (BG 9) had to be deployed for pile installation. • The underlying limestone formation also posed a challenge as the termination depth had to be closely controlled, and confirmed by the Engineer's Representative.
		
Inai Shaft No.3	• Shaft dimension: 20m (outer diameter) • Excavation depth: 43m • Diameter of SBP: 1180mm • Total piles installed: 68	• Installation of SBPs in difficult karstic limestone formation. • Overcoming cavities and water seepage.
Escape Shaft No.3	• Shaft dimension: 16m x 8m • Excavation depth: 43m • Diameter of SBP used: 880mm and 1180mm • Total piles installed: 68	
	 Inai Shaft No.3	 Escape Shaft No.3
Intervention Shaft No.2	• Shaft dimension: 20m x 25m • Excavation depth: 34m • Diameter of SBP: 1180mm	• Installation of deep cased SBP in karstic limestone formation required close monitoring and control.

	• Total piles installed: 100	• Limited working space.
		

Note: Figures have been extracted from the presentation slides

In conclusion, the webinar was highly informative as Mr Vijayakumar managed to elaborate on some of the interesting challenges that were encountered and how they were overcome. Towards the end of the webinar, Mr Vijayakumar also shared additional photographs of the construction work at each MRT station and shaft.